New Class of Coherently Excited Interfacial Acoustic Waves Observed in Transient Surface Grating Experiments

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We report the observation of a new class of interfacial acoustic waves in the gas above opaque samples excited by pulsed laser radiation in transient surface grating experiments. They differ from previously described interfacial waves in the coupling between the media: Stoneley [1], Scholte [2], and others, e.g. [3], all considered waves that are coupled by mechanical interactions across the interface, whereas the waves we observed were found to be coupled by thermal interactions. They manifest themselves in transient surface grating experiments as sinusoidal intensity modulations of the diffracted probe laser beam, at frequencies that indicate that their propagation velocities are very close to those of freely propagating acoustic waves in the gas.

We present a theoretical analysis based on approximate solutions to the Navier-Stokes equations, which shows that the observations are best described by an adiabatic thermal interaction model. The model relates the amplitudes and propagation velocities of the interfacial waves to the thermal, mechanical and optical properties of the adjoining media. Finally we show how such waves affect thermophysical measurements and indicate briefly other potential applications areas.

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